District of Columbia
Office of the State Superintendent of Education

DC SCIENCE 2015
SAMPLE ITEMS

Guide To DC Sample Items for:
Grade 5 | Grade 8 | HS Biology

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Office of the State Superintendent of Education
DC Science 2015 Sample Items

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Introduction

In 2013, the District of Columbia adopted the Next Generation Science Standards (NGSS). The NGSS reflects the integration of science and engineering content and application as it is practiced in the real world. The standards were developed through a collaborative state-led process and based on the National Research Council's *Framework for K-12 Science Education.*

The NGSS performance expectations describe what students should know and are able to do in order to demonstrate proficiency. Each performance expectation consists of three dimensions: Disciplinary Core Ideas, Science and Engineering Practices, and Cross Cutting Concepts.

Table 1: Dimensions of the NGSS

Dimensions	Description
Disciplinary Core Ideas (DCI)	Concepts in science and engineering that have broad importance within and across disciplines as well as relevance to people's lives.
Science and Engineering Practices (SEPs)	Activities that scientists and engineers engage in, to either understand the world or solve a problem.
Crosscutting Concepts (CCs)	Ideas that are not specific to any one discipline but cut across all disciplines.

DC Science Assessment uses interrelated questions to adequately assess the new standards. The goal of real-world context or scenarios is to engage students and assess three-dimensional science learning.

Transition to Next Generation Science Standards

As the implementation of Next Generation Science Standards (NGSS)-aligned curriculum and instruction is still on a transitional pathway in the District, the new DC Science Assessment is being developed with this in mind. In spring 2015, the OSSE field-tested a DC Science Assessment that reflects the District's transition to NGSS. The field test was administered online to students in grades 5, 8 and high school biology in the same platform used for the PARCC assessments.

The 2015 assessment integrated technology-enhanced NGSS-based items with science item formats used previously in Districtwide assessments. The field-test consisted of 16 new scenario-based items and District of Columbia Comprehensive Assessment System (DC CAS) items at each grade level.

Newly developed items will consist of real world scenarios that address the dimensions of the NGSS: DCIs, SEPs and CCCs. Each scenario-based event will contain the

following item types: technology-enhanced items, constructed response items, and selected-response items. Technology-enhanced items may require students to drag and drop pictures to create models. Constructed response items provide students an opportunity to use evidence to construct an explanation. Selected-response items may ask students to select all the answer choices that apply providing a better picture of student understanding of content.

Sample Item Booklet Overview

The Sample Item Booklet is a guide to provide general information about the DC Science assessment for parents, families, and District educators. The items are representative of the questions on the spring, 2015 science field test. Items reflect the three-dimensional nature of the standards, exploring student understanding of the Next Generation Science Standards (NGSS) across multiple dimensions and bundled performance expectations. There are no restrictions to reproducing any of the materials contained in the booklet.

Each grade-level section contains six sample assessment questions, item specific scoring guides and rubrics, and item background information. Each item begins with an overview of NGSS properties including supporting evidence statements followed by the assessment question. A glossary of terms and list of additional resources and links to NGSS websites are available at the end of the document. OSSE will provide opportunities for feedback, educator training, and technical support to educators, schools, and LEA’s throughout the process.

Glossary of Terms

Constructed Response Items(CR)	When responding to a CR item, students write their own answers.
Cross Cutting Concepts (CCC)	Concepts, such as—patterns, cause and effect, scale, systems and system models, energy and matter, structure and function, and stability and change—cut across the disciplines of science uniting core ideas throughout science and engineering. CCC help students deepen their understanding of core content and connect knowledge across disciplines.
Disciplinary Core Ideas (DCI)	DCIs identify core content in Physical Science, Life Science, Earth and Space Science, and Engineering. The NGSS contain a limited number of DCIs at each grade level allowing students to explore content and practices at a deeper level.
Disciplines	The disciplines of science and engineering addressed in NGSS include: Physical Science, Life Science, Earth and Space Science, and Engineering.
Evidence Statements (ES)	Evidence statements provide clear, measurable components of the three dimensions—SEP, CCC, and DCI—of each PE. The evidence statements provide detail on how students will use the practices, crosscutting concepts, and disciplinary core ideas together in their demonstration of proficiency on the PEs by the end of instruction.
Metadata	Metadata provide the background information for each item including: the alignment of the item to the PE, SEP, CCC, DCI and ES. The metadata also identify the item type.
Performance Expectations (PE)	PEs describe what students should be able to demonstrate at the end of instruction at each grade level. Each PE represents the integration of three "dimensions" of science education: scientific and engineering practices, disciplinary core ideas, and crosscutting concepts.
Scientific and Engineering Practices (SEP)	Eight practices—asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, developing explanations or solutions, engaging in argument from evidence, and evaluating and communicating information—describe behaviors that scientists and engineers engage in as they investigate and build models and theories about the natural world, and as they design and build models and systems. Students need to engage in these practices to truly understand the core ideas in the disciplines of science.
Scoring Rubric	A set of criteria used to score student responses to the CR items. The criteria are associated with points. Teachers assign points for correct responses and then tally the points for a score for the item.
Select Response Items (SR)	When responding to a SR item, students choose one of four pre-written answer choices that they think is correct.
Technology Enhanced Items (TEI)	TEIs are administered in an online environment. Students respond to four types of TEIs as described below: • Drag and Drop: Using the mouse or arrows to drag and drop an object into a box or on a model. • Select All That Apply: A select response item that allows students to choose multiple answer choices. • Fill-In-The-Table: Students enter data into a table. • Drop-Down Menus: Clicking on drop-down menus and select an option from the list of choices.

DC Science 2015 Sample Items: Core Concepts by Grade Level

The table below provides an "at-a glance" overview of the performance expectations associated with each sample item.

Grade	Item Number	Page Number	Physical Science	Life Science	Earth Science	Engineering
5	1	8		5LS1-1		
5	2	12		5LS2-1		
5	3	14		5LS2-1		
5	4	16	5PS3-1			
5	5	18			5ESS3-1	
5	6	20				3-5ETS1-1
8	1	24				MS-ETS1-1
8	2	24				MS-ETS1-1
8	3	26				MS-ETS1-3
8	4	30				MS-ETS1-2
8	5	32				MS-ETS1-2
8	6	34				MS-ETS1-3
HS	1	38		HSLS1-7		
HS	2	40		HSLS1-5		
HS	3	42		HSLS2-5		
HS	4	44		HSLS2-3		
HS	5	46				HS-ETS1-1
HS	6	50				HS-ETS1-1

DC Science 2015 Sample Items

Grade 5

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Item 1: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	5LS1-1	Support an argument that plants get the materials they need for growth chiefly from air and water.
Science & Engineering Practice(s)	4 6	Analyzing and interpreting data Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Construct explanations Construct an explanation of observed relationships and identify the evidence that supports particular points in an explanation
Disciplinary Core Idea(s)		
Cross cutting Concept(s)		
Evidence Statement(s)	2ai 4aiii	(2) Identifying scientific evidence (a) Students describe the evidence/data that support the claim, including evidence of: (i) Plant growth over time. (4) Reasoning and synthesis (a) Students use reasoning to connect evidence to support the claim with argumentation. (iii) Plants do not acquire most of the material for growth from soil.
Item Format	CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
1	0-3	1 Pt: Indicates that Kayla's claim is correct. 1 Pt: Includes an explanation indicating why Kayla's claim is correct. [Plants acquire their material for growth chiefly from air and water. Plant matter comes mostly from air and water not from soil.] [Common misconception is that soil is the primary source of matter for plants.] 1 Pt: Cites and correctly uses evidence from the data table indicating that the plants grown in water were larger—longer stems.

Scoring Notes:

- Assign one point for each criterion addressed in the student response.
- Tally the number of points. If only one criterion is addressed—score 1. If two criterions are addressed—score 2. If all three criterions are addressed—score 3.

Item 1

Trevor and Kayla's school takes part in the District of Columbia School Garden Program. Trevor's class is growing bean plants in soil in the school garden.

Kayla's class is growing bean plants in soda bottles filled with water and nutrients in the classroom. Growing plants in water and nutrients is called hydroponics.

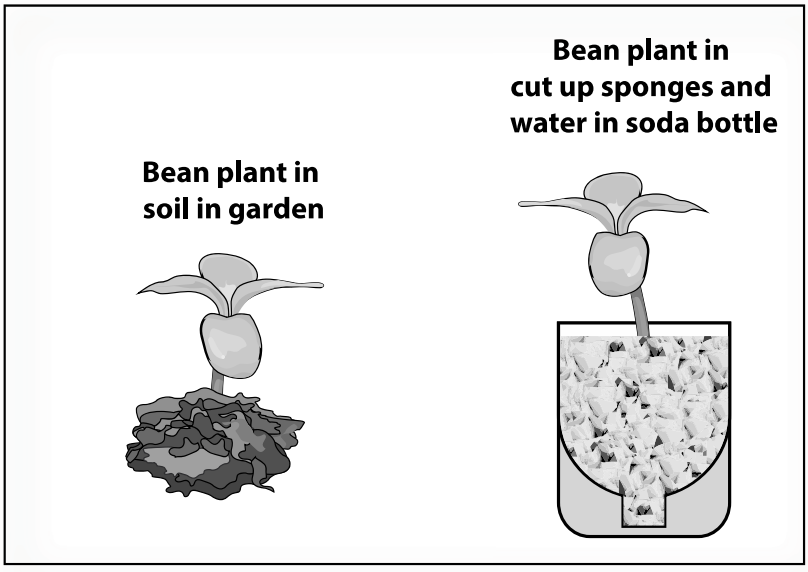
Kayla's class made their own hydroponics system by doing the following steps:

1. Removing the bottle cap
2. Cutting the bottle in half
3. Putting the top half of the bottle into the bottom half of the bottle
4. Mixing nutrients into the water
5. Placing the water in the bottom of the bottle
6. Adding cut up sponges to the top half of the bottle

Trevor and Kayla wondered if the plants would grow better in soil or in water. To find out, they did the following experiment:

- Trevor and Kayla planted their bean plants at the same time.
- Trevor planted his plants in the soil in the garden.
- Kayla planted her plants in water in the bottle.
- Both students watered their seeds every 2–3 days.
- Both students' plants received the same amount of sunlight each day.

The pictures below show a bean plant in soil and a bean plant in water.



Trevor and Kayla observed the growth of their plants for one month. They measured the height of the stems every week for four weeks and recorded their results below.

Bean Plants Grown in Soil				
	Week 1	**Week 2**	**Week 3**	**Week 4**
Stem Height	4.5 cm	7.2 cm	10.6 cm	13.1 cm

Bean Plants Grown in Water				
	Week 1	**Week 2**	**Week 3**	**Week 4**
Stem Height	5.4 cm	8.6 cm	12.1 cm	15.4 cm

Based on these results, Trevor and Kayla made the following claims:

Trevor: The bean plants grew faster in the soil in the garden because soil provides the nutrients for plants to grow.

Kayla: The bean plants grew better in water in the soda bottles because water provides the nutrients for plants to grow.

Study the data in the tables and Trevor and Kayla's claims.

Whose claim is correct, Trevor's or Kayla's? Explain why Kayla's or Trevor's claim is correct. Use evidence to support your choice.

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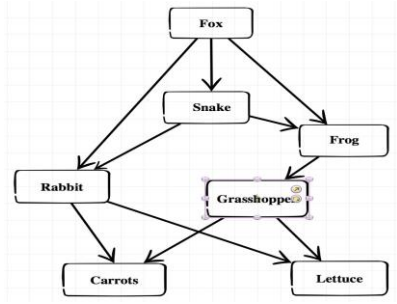
Item 2: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	5LS2-1	Develop a model to describe the movement of matter among plants, animals, decomposers and the environment.
Science & Engineering Practice(s)	2 6	Developing and using models Develop or revise a model that shows the relationship among variables for frequent and regular occurring events. Constructing explanations Construct an explanation of observed relationships and identify the evidence that supports particular points in an explanation.
Disciplinary Core Idea(s)	LS2.A	The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.
Cross cutting Concept(s)	Systems and System Models	A system can be described in terms of its components and their interactions.
Evidence Statement(s)	1ai, ii, iii 2ai-1 & 2 3ai	(1) Components of a model (a) Students develop a model to describe a phenomenon that includes the movement of matter within an ecosystem. In the model students identity: (i) matter; (ii) plants; and (iii) animals. 2. Relationships (a) Students describe the relationship among components that are relevant for describing the phenomenon, including: (i) the relationships in the system between organisms that consume other organism, including: (1.) animals that consume other animals and (2) animals that consume plants. 3 Connections (a) Students use the model to describe: (i) The cycling of matter in the system between plants, animals and the environment.
Item Format	TEI / CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
2	0-12	 11 Pts: Correctly drag and drops organisms in the food web. (Partial credit for correct pairs of organisms going in the right direction. For example, the student might construct—fox to snake, fox to rabbit, etc. Plants can be in either of the bottom boxes.) 1 Pt: Provides a reasonable explanation for the shortest way the fox gets its energy from plants. [For example: The fox gets its energy by eating the rabbit that eats carrots or lettuce.]

Scoring Notes:

- Assign one point for each criterion addressed in the student response.
- Tally the number of points. If only one criterion is addressed—score 1. If two criterions are addressed—score 2. If all three criterions are addressed—score 3 and so on.

Item 2

Trevor and Kayla learned that organisms can only survive in environments that have the food and energy they need.

Construct a model of a food web by dragging and dropping the pictures of the organisms into the boxes below.

Grasshopper

Rabbit

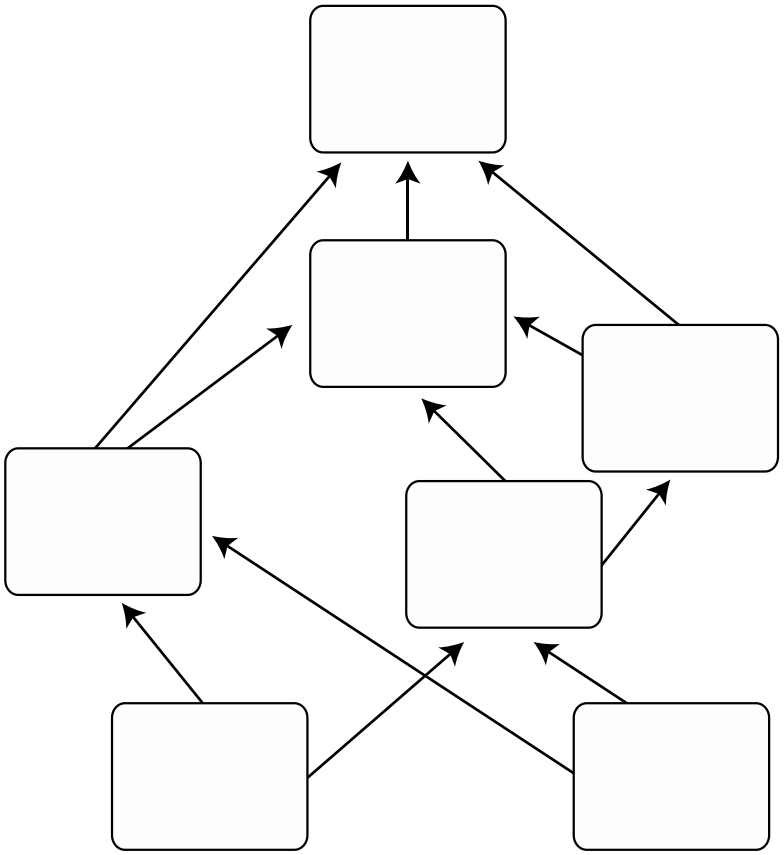
Frog

Carrots

Snake

Lettuce

Fox



Explain how your model shows the shortest way that the energy from plants gets to the fox.

Item 3: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	5LS2-1	Develop a model to describe the movement of matter among plants, animals, decomposers and the environment.
Science & Engineering Practice(s)	2 6	Developing and using models Develop or revise a model that shows the relationship among variables for frequent and regular occurring events. Constructing explanations Construct an explanation of observed relationships and identify the evidence that supports particular points in an explanation.
Disciplinary Core Idea(s)	LS2.A	The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.
Cross cutting Concept(s)	Systems and System Models	A system can be described in terms of its components and their interactions.
Evidence Statement(s)	2ai-1 & 2 3ai	2. Relationships (a) Students describe the relationship among components that are relevant for describing the phenomenon, including: (i) the relationships in the system between organisms that consume other organisms, including: (1.) animals that consume other animals; (2) animals that consume plants;(3) organisms that consume dead plants and animals; and (4) movement of matter between organisms during consumption. (3) Connections (a) Students use the model to describe: (i) The cycling of matter in the system between plants, animals and the environment.
Item Format	TEI / CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
3	0-7	3 Pts: Selects all three correct answer choices—B, D, and E 2 Pts: Selects two correct answer choices 1 Pt: Selects one correct answer choice Plus 4 Pts: Correctly describes the relationship between organisms and the exchange of matter from and back into the environment. Correct responses would include the following: • Organisms in food chains/webs are related in which some animals eat plants for food and other animals eat the animals that eat plants • Bacteria break down dead plants, plant parts and animals and function as decomposers • Decomposition recycles some materials/nutrients back into the environment • Organisms obtain matter from their environments for life processes and release waste back into the environment

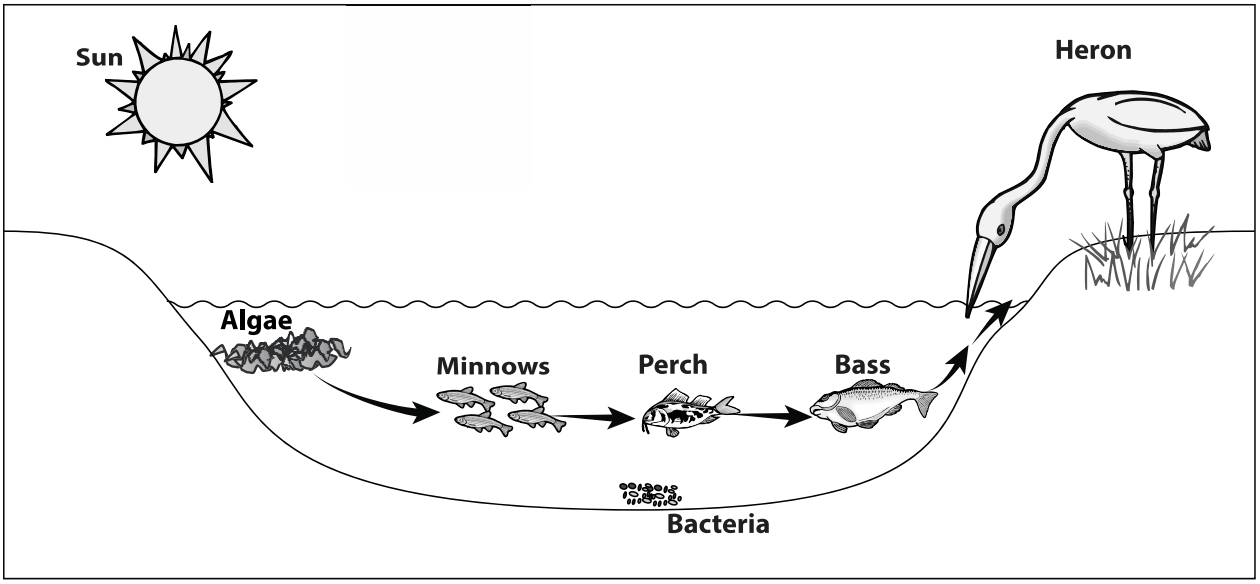
Scoring Notes:

- Assign one point for each criterion addressed in the student response.
- Tally the number of points. If only one answer is selected—score 1. If two one answers are selected —score 2. If all three answers are selected —score 3.
- Combine the number of correct responses with the total points for constructed response.

Item 3

Kayla's class was learning about different kinds of food chains. Her teacher showed the class the model of a pond food chain below.

Model of a Pond Food Chain



Look at the model of the pond food chain. Which of the following statements best describes the movement of matter in the pond food chain? Select three correct answers.

A. Animals will eat whatever food is available in the pond.

B. Some animals in the pond eat plants.

C. When plants and animals die, they are no longer part of a food chain.

D. Some animals in the pond eat other animals.

E. Some organisms in the pond break down dead organisms.

F. The plants, animals, and bacteria in the pond food chain are not related.

Use the model of the pond food chain to describe the relationship between the organisms in the pond food chain and the exchange of matter back into the environment.

Item 4: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	5PS3-1	Use models to describe that energy in animals' food was once energy from the sun.
Science & Engineering Practice(s)	2	Developing and using models Develop or revise a model that shows the relationship among variables for frequent and regular occurring events.
Disciplinary Core Idea(s)	PS3.D	The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).
Cross cutting Concept(s)	Energy & Matter	Energy & Matter Matter is transported into, out of, and within systems.
Evidence Statement(s)	1a	(1) Components of the model (a) Students use a model to describe a phenomenon that includes the idea that energy in animals' food was once energy from the sun.
Item Format	TEI	

Scoring Rubric:

Item	Number of Points	Scoring Criteria

4	0-4	4 Pts: One point for each correctly ordered organism in the food chain.
		• Correct order of organisms in the food chain:
		  ○ Tomatoes
		  ○ Snail
		  ○ Chicken
		  ○ Children

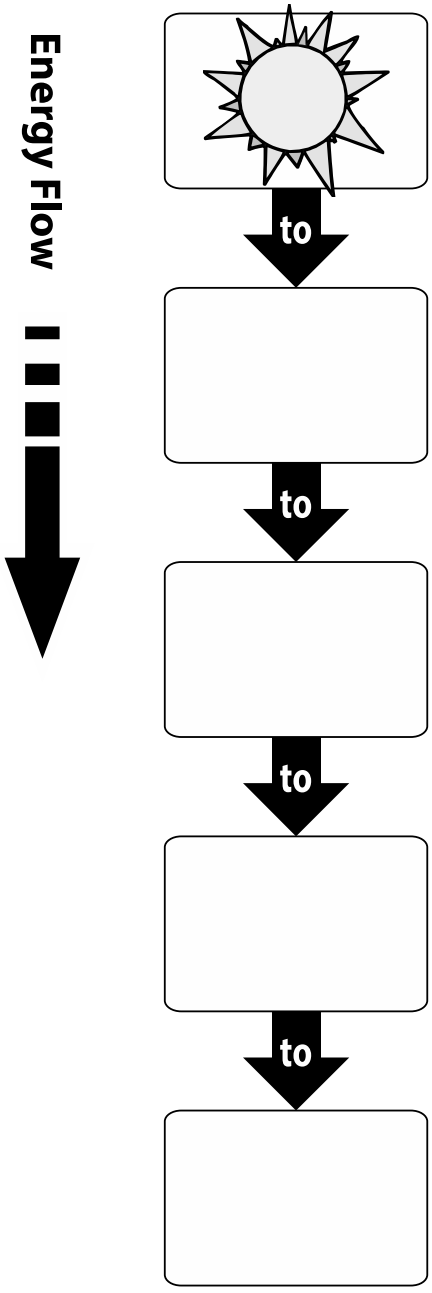
Scoring Notes:

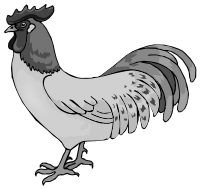
- Assign one point for each organism that is in the correct position; tally the points.

Item 4

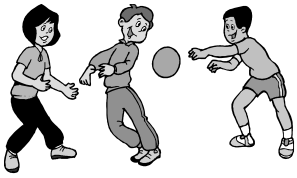
Trevor and Kayla wondered where plants get energy to grow.

Drag and drop each picture into the correct box to show how energy moves through the food chain.

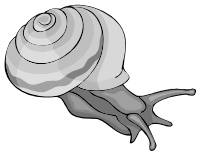




Chicken



Children



Snail

Tomatoes

Item 5: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	5-ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
Science & Engineering Practice(s)	8	Obtaining, evaluating and communicating information Communicate scientific and/or technical information in writing.
Disciplinary Core Idea(s)	ESS3.C	Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.
Cross cutting Concept(s)	Systems and System Models	A system can be described in terms of its components and their interactions.
Evidence Statement(s)	2aii	(2)Obtaining information (a) Students obtain information from books and other reliable media about: (ii) How a given community uses scientific ideas to protect a natural resource.
Item Format	TEI	Select all that apply

Scoring Rubric:

Item	Number of Points	Scoring Criteria
5	0-3	3 Pts: Selects all three correct answers—A, D, & E. 2 Pts: Selects two correct answers. 1 Pt: Selects one correct answer. Answer choices: A. Correct B. Not Correct C. Not Correct D. Correct E. Correct

Scoring Notes:

- Assign one point for each correct response; tally the number of points.

Item 5

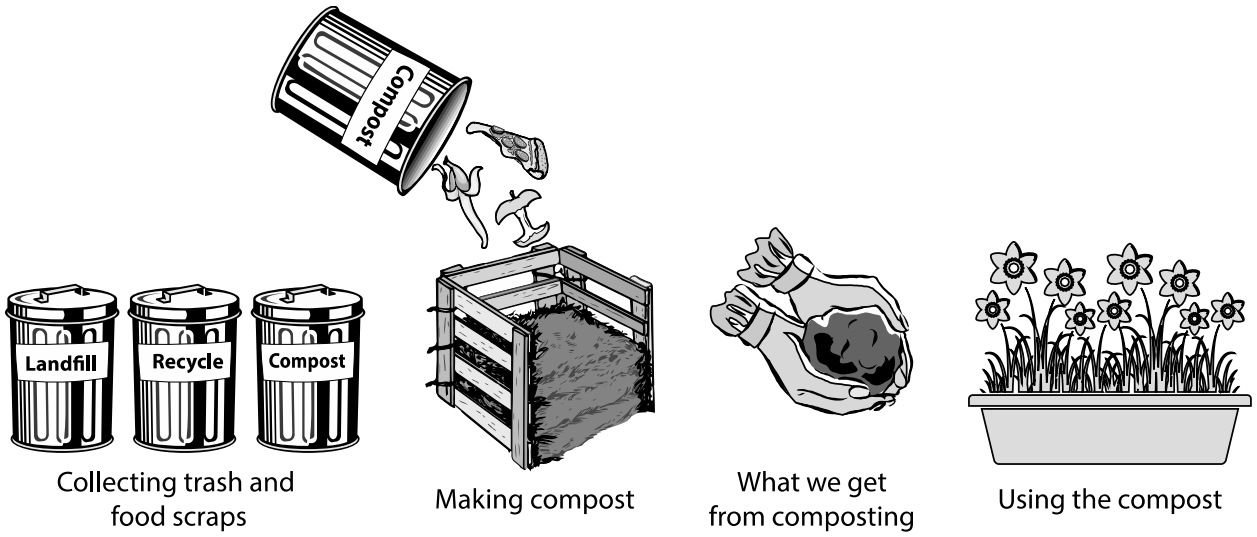
Kayla was eating lunch in the school garden. Next to the recycling bin she saw a new bin labeled Compost Bin. She asked her teacher what she should put in the compost bin.

Her teacher said that compost is a type of soil that results from the breakdown of natural materials like fruit and vegetable peels and leaves. This soil can be added to gardens.

Picture 1 shows how students can sort waste into landfill, recycle, and/or compost bins.

Picture 2 shows that items from the compost bin are collected and added to a compost pile. Decomposers take in oxygen as they break down the material and create heat, water, and carbon dioxide. The remaining material is nutrient-rich soil.

Picture 3 shows students using soil from the compost pile in the school garden.



Which of the following statements best explains why composted soil is good for plants in the garden and for the environment? Select three correct answers.

A. Compost provides plants with many of the nutrients they require.

B. The bad smell of rotting food keeps away harmful insects.

C. Plastic bottles break down in a compost bin.

D. Composting saves money because you do not need to buy soil every year.

E. Composting keeps resources in the community and out of the landfill.

Item 6: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	3-5 ETS1-1	Define a simple design problem reflecting a need or want that includes specific criteria for success and constraints on materials, time or cost.
Science & Engineering Practice(s)	6	Constructing explanations Construct an explanation of observed relationships and identify the evidence that supports particular points in an explanation
Disciplinary Core Idea(s)	ETS1.A	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria).
Cross cutting Concept(s)	Influence of Engineering, Technology and Science on Society and the Natural World	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.
Evidence Statement(s)	1a 2a 3a 3b i, ii, iii	(1) Identifying the problem to be solved (a) Students use scientific information and information about a situation or phenomenon to define a simple design problem that includes responding to a need or want. (2) Defining the boundaries of the system (a) Students define the limits within which the problem will be addressed, which includes addressing something people want and need at the current time. (3) Defining the criteria and constraints (a) Based on the situation people want to change, students specify criteria (required features) of a successful solution. (3) Defining the criteria and constraints (b) Students describe the constraints or limitations on their design which may include: (i) cost; (ii) materials; and (iii) time.
Item Format	CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
6	0-3	1 Pt: Identifies the solution that best fits the criteria: install physical barrier. 1 Pt: Cites and correctly uses evidence from the data table indicating that the physical barrier solution is best because it has high ratings for safety, effectiveness, and effort, and it has a low impact on the environment. The cost is moderate—which indicates that it is within reason and not too high. 1 Pt – Response uses evidence from the table to explain why using cats or vibrating stakes is not a good solution.

Scoring Notes:

- Assign one point for each correct response; tally the number of points.
- Simply counting “highs” will not provide the correct answer. Students need to think through each option – depending on the solution “high” can be either a positive or a negative.

Item 6

One day Trevor saw that some plants in the garden had disappeared. A teacher said that the garden had moles. Moles eat the roots of plants, which cause the plants to die.

Trevor looked into three solutions to prevent the moles from eating the plants in the garden:

- Put up a physical barrier
- Put cats in the garden
- Install battery-operated vibrating [1] stakes to scare the moles away

Trevor's teacher helped the class come up with the following criteria for the best solution:

1. **Safety:** It could not be dangerous or unhealthy.
2. **Usefulness:** It stops the moles from eating the plants.
3. **Amount of Work:** It does not take much work.
4. **Cost:** It is not too expensive.
5. **Environment:** It does not harm the environment.
6. **Time:** It does not take much time to keep the solution working.

The decision table below shows how Trevor rated each solution based on the six criteria.

Decision Table

Criteria	Solutions		
	Install Physical Barrier	**Put Cats in Garden**	**Vibrating Stakes**
1. Safety	High	Moderate	High
2. Usefulness	High	Moderate	Moderate
3. Amount of Work	High	Moderate	Moderate
4. Cost	Moderate	Moderate	High
5. Environment	Low	High	Low
6. Time	Low	High	Moderate

6. Which of the three solutions best meets the six criteria? Use evidence from the table to explain your answer.

[1] Vibrating: moving very fast back and forth, often-creating sounds.

DC Science 2015 Sample Items

Grade 8

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Items 1 and 2: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	MSETS-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Science & Engineering Practice(s)	1	Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
Disciplinary Core Idea(s)	ETS1.A	Defining and Delimiting Engineering Problems The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.
Cross cutting Concept(s)	Influence of Science, Engineering and Technology on Society and the Natural World	Influence of Science, Engineering and Technology on Society and the Natural World All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
NGSS Evidence Statement(s)	3a	(3) Defining criteria and constraints (a) Students define criteria that must be taken into account in the solution (b) Students define constraints that must be taken into account in the solution
Item Type	TEI	Select all that apply

Scoring Rubric:

Item	Number of Points	Scoring Criteria
1	0-3	3 Pts: Selects three correct answers—B, C, & E. 2 Pts: Selects two correct answers. 1 Pt: Selects one correct answer. • Not correct: A, D, F, and G

Item	Number of Points	Scoring Criteria
2	0-3	3 Pts: Selects three correct answers—C, E, and F. 2 Pts: Selects two correct answers. 1 Pt: Selects one correct answer. • Not correct: A, B, D, and G

Scoring Notes:

- Assign one point for each correct answer. Tally the points.

Items 1 and 2

Teams of middle school students from Washington, DC are participating in an engineering competition. In this competition, the teams must develop solutions to several design challenges. The team is made up of Marcus, Anna, and Makayla. The students are excited because they like working together and solving engineering problems.

The first challenge is to design and construct a device that launches a Ping-Pong ball. The ball must travel through the air a distance of 3 meters and land on a target. The device can't use electricity and must cost $15 or less.

The teams learned that engineers always think about *criteria* and *constraints* when designing solutions to solve a problem:

- *Criteria are requirements for a successful solution. Criteria identify the functions that a design is expected to perform.* For example, criteria for building an automobile might include that the auto must hold up to four passengers and cannot cost more than $7,500.
- *A constraint is a limitation that must be taken into account when designing the solution.* For example, the materials for the automobile must meet minimum safety standards and weigh less than 4,500 pounds.

1. Select all statements that meet the *criteria* of the design problem.
   A. The device must use a rubber band.
   B. The device must launch a ball 3 meters.
   C. The device must cause a ball to land on a target.
   D. The device must weigh more than 2 kg.
   E. The device must cause a ball to travel through the air.
   F. The device must launch any small-sized ball.
   G. The device must land a ball within 3 feet of a target.

2. Select all statements that meet the *constraints* of the design problem.
   A. The device can't weigh more than 3 kg.
   B. The device can't use rubber bands.
   C. The device can't cost more than $15
   D. The device must launch a white ball.
   E. The device can't use electricity.
   F. The device must be designed and constructed by the group.
   G. The device must be constructed out of recycled materials.

Item 3: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
Science & Engineering Practice(s)	7	Engaging in Argument from Evidence Construct an argument supported by evidence and scientific reasoning to support or refute an explanation or a solution to a problem.
Disciplinary Core Idea(s)	ETS1.B ETS1.C	Developing Possible Solutions There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Optimizing the Design Solution Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.
Cross cutting Concept(s)	Influence of Science, Engineering and Technology on Society and the Natural World	Influence of Science, Engineering and Technology on Society and the Natural World All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
NGSS Evidence Statement(s)	2a 3a & b	(2) Identifying relationships (a)Students use appropriate analysis techniques (e.g., qualitative or quantitative analysis; basic statistical techniques of data and error analysis) to analyze the data and identify relationships within the datasets, including relationships between the design solutions and the given criteria and constraints. (3) Interrupting data (a) Students use the analyzed data to identify evidence of similarities and differences in features of the solutions. (b) Based on the analyzed data, students make a claim for which characteristics of each design best meet the given criteria and constraints.
Item Type	CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
3	0-7	1 Pt: Student recommends to continue to work on Design A 1 Pt: Student recommends to continue to work on Design D 1 Pt: Student states that designs A and D appear to meet all the criteria and constraints. 1 Pt: Student recommends to stop working on Design B 1 Pt: Student states that design B does not launch the ball through the air and that does not meet one of the criteria. 1 Pt: Student recommends to stop working on Design C 1 Pt: Student states that design C costs more than $15 and uses electricity and that does not meet two of the constraints.

Scoring Notes:

- Assign one point for each correct answer. Tally the points.

Item 3

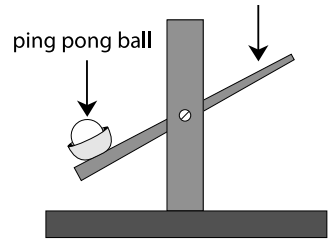
In the first step of the design process, Anna and Makayla made sketches of their design solutions. They used the sketches to determine which of their ideas have the best potential.

Marcus created a decision table so the team could evaluate the different design ideas.

Below are the sketches for four designs and the decision table:

A. Catapault design sketch

Estimated cost: $9

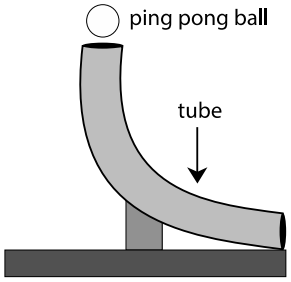


Student applies downward force.

Direction of Target

B. Tube design sketch

Estimated cost: $10

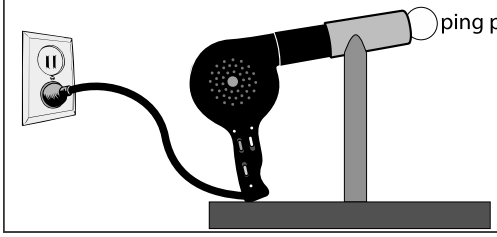


Ball is released and allowed to roll down.

Direction of Target

C. Hair dryer design sketch

Estimated cost: $23

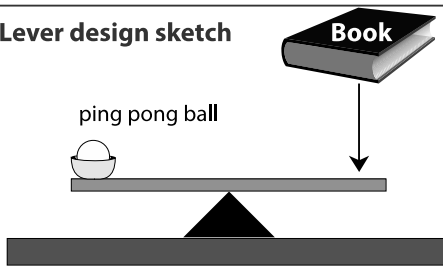


Ball is released into the tube.
Hair dryer is turned on and launches the ball.

Direction of Target

D. Lever design sketch

Estimated cost: $6



Book dropped from a height of 1/2 meter to apply downward force.

Direction of Target

Decision Table:

Design Factors	Design A	Design B	Design C	Design D
Launches ball through the air	Yes	No	Yes	Yes
Cost is $15 or less	Yes	Yes	No	Yes
Does not use electricity	Yes	Yes	No	Yes

Which design solutions should be built and tested? Explain your decision. Also, explain why they should not work on each of the other design solutions. Support your explanations with evidence from the design sketches and decision table.

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Item 4: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
Science & Engineering Practice(s)	8	Obtaining, evaluating and communicating information. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.
Disciplinary Core Idea(s)	ETS1.B	Developing possible solutions. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
Cross cutting Concept(s)	Influence of Science, Engineering and Technology on Society and the Natural World	Influence of Science, Engineering and Technology on Society and the Natural World All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
NGSS Evidence Statement(s)	3a 3b	(3) Defining criteria and constraints (a) Students define criteria that must be taken into account in the solution (b) Students define constraints that must be taken into account in the solution (3) Defining criteria and constraints (b) Students define constraints that must be taken into account in the solution
Item Type	TEI	Fill in the table

Scoring Rubric:

Item	Number of Points	Scoring Criteria
4	0-10	1 Pt: Selects correct answers for criteria, constraints, and neither. • Criteria: 1, 4, 6, and 7 • Constraints: 2, 3, 5, and 9 • Neither: 8 and 10

Scoring Notes:

- Assign one point for each correct answer. Tally the points.

Item 4

Marcus, Anna and Makayla also participated in the paper airplane challenge. In this challenge, teams are required to design and construct a paper airplane that can travel at least 3 meters and stay in the air as long as possible. The airplanes must:

- have a tail.
- be constructed of a standard-size sheet of paper.
- be easily seen when it flies and lands.
- be built within 30 minutes.

The teams learned that engineers always think about *criteria* and *constraints* when designing solutions to solve a problem:

- *Criteria are requirements for a successful solution. Criteria identify the functions that a design is expected to perform.* For example, criteria for building an automobile might include that the auto must hold up to four passengers and cannot cost more than $7,500.
- *A constraint is a limitation that must be taken into account when designing the solution.* For example, the materials for the automobile must meet minimum safety standards and weigh less than 4,500 pounds.

Marcus, Anna and Makayla made a list of criteria and constraints and listed them in the design table below.

Place an X in the design table below showing which characteristics are criteria, which are constraints, and which are neither:

Design Table

Characteristics	Criteria	Constraints	Neither
1. Made from a single sheet of standard sized paper			
2. Length of the plane			
3. Width of the plane			
4. Easily seen when flies and lands			
5. Made within 30 minutes			
6. Has a tail			
7. Travels at least 3 meters			
8. Has turned-up wings			
9. Width of the plane			
10. Has a sharp nose			

Item 5: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
Science & Engineering Practice(s)	8	Obtaining, evaluating and communicating information. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.
Disciplinary Core Idea(s)	ETS1.B	Developing Possible Solutions There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.
Cross cutting Concept(s)	Influence of Science, Engineering and Technology on Society and the Natural World	Influence of Science, Engineering and Technology on Society and the Natural World All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
NGSS Evidence Statement(s)	3a 3b	(3) Defining criteria and constraints (a)Students define criteria that must be taken into account in the solution (b)Students define constraints that must be taken into account in the solution (3) Defining criteria and constraints (b)Students define constraints that must be taken into account in the solution
Item Type	CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
5	0-3	1 Pt: Recommend making a paper airplane that is short and has turned-up wings. 1 Pt: Turned-up wings increase hang time because Design A and Design C have the longest hang time for their respective designs. 1 Pt: Longer plane length increases the length of the flight because Design C and Design D flew longer distances than Design A and Design B.

Scoring Notes:

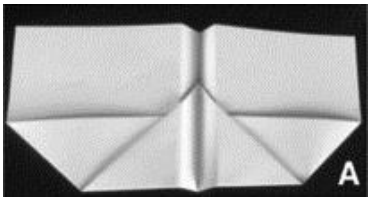
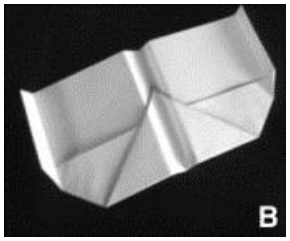
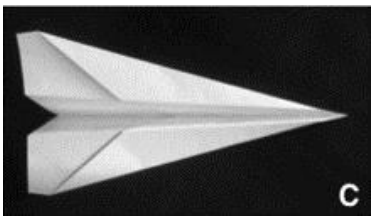
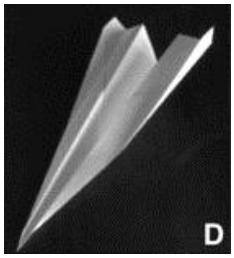
- Assign one point for each correct answer. Tally the points.

Item 5

Marcus and Anna designed two paper airplanes with flat wings. Makayla designed two paper airplanes with turned-up wings.

Picture 1 below shows the four different designs.

Picture 1: Four Different Airplane Designs

	Flat Wings	Folded Wings
Short Planes		
Long Planes		

The students tested each design and recorded their results in Table 1 below.

Table 1: Results for the Four Airplane Designs

Characteristics	Design A	Design B	Design C	Design D
Average distance traveled	1.00 meters	1.45 meters	1.50 meters	2.15 meters
Average time plane stays in the air	11 seconds	8 seconds	4 seconds	3 seconds
Length of plane (cm)	15 cm	15 cm	28 cm	28 cm
Wing shape	Flat	Turned-up	Flat	Turned-up

Use the results in Table 1 above to describe the best possible design for a plane that both travels a long distance and stays in the air a long time. Explain your recommendation and use evidence to support the reasons for your selection.

Item 6: Metadata, Scoring Rubric, & Scoring Notes

Performance Expectation	MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
Science & Engineering Practice(s)	7	Engaging in Argument from Evidence Construct an argument supported by evidence and scientific reasoning to support or refute an explanation or a solution to a problem.
Disciplinary Core Idea(s)	ETS1.B ETS1.C	Developing Possible Solutions There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Optimizing the Design Solution Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.
Cross cutting Concept(s)	Influence of Science, Engineering and Technology on Society and the Natural World	Influence of Science, Engineering and Technology on Society and the Natural World All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
NGSS Evidence Statement(s)	3a 3b	Interpreting data (a) Students use the analyzed data to identify evidence of similarities and differences in features of the solutions. (b) Based on the analyzed data, students make a claim for which characteristics of each design best meet the given criteria and constraints.
Item Type	TEI	Select all that apply

Scoring Rubric:

Item	Number of Points	Scoring Criteria
6	0-4	2 Pts: Selecting B and D 1 Pt: Selecting B OR D 2 Pts: An explanation with evidence from the table 1 Pt: An explanation without evidence

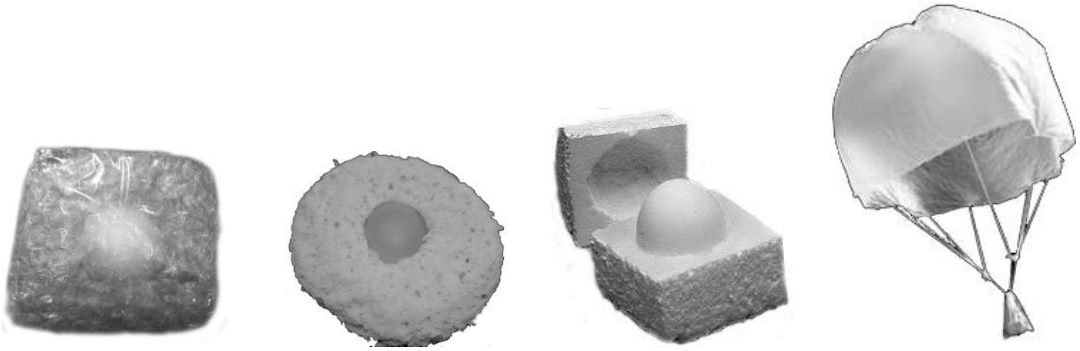
Scoring Notes:

- Assign one point for each correct answer. Tally the points.

Item 6

In the egg drop challenge, teams must design and construct a device that will protect an egg from breaking when it is dropped from different heights. A student must be able to hold the final design in their hand.

In order to decide on the best design for their device, Marcus, Anna, and Makayla tested several options. The picture below shows their four options.



Egg wrapped in bubble wrap | Egg wrapped in sponge | Egg wrapped in Styrofoam | Egg attached to parachute

To test their designs they dropped eggs from different heights to see what would happen. The results of their tests are shown in the table below:

Egg drop test results	**Distance dropped:**			
Device:	**2 meters**	**4 meters**	**6 meters**	**8 meters**
Egg wrapped in bubble wrap	intact	broke	broke	broke
Egg wrapped in sponge	intact	intact	intact	broke
Egg wrapped in Styrofoam	broke	broke	broke	broke
Egg attached to a parachute	broke	broke	intact	intact

Based on their test results, which combination of design solutions do you recommend they use to build their egg container? Select all that apply:

A. Egg wrapped in bubble wrap
B. Egg wrapped in sponge
C. Egg wrapped in Styrofoam
D. Egg attached to a parachute

Use evidence from the table to explain why you chose your design solution.

DC Science 2015 Sample Items

High School Biology

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Item 1: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
Science & Engineering Practice(s)	2	Developing and Using Models. Use a model based on evidence to illustrate the relationships between systems or between components of a system.
Disciplinary Core Idea(s)	LS1.C	Organization for Matter and Energy Flow in Organisms. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.
Cross cutting Concept(s)	Energy and Matter	Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.
NGSS Evidence Statement(s)	1a	Components of the model (a) From the given model, students describe the relationships between components, including: (i) Carbon dioxide and water are produced from sugar and oxygen by the process of cellular respiration; and (ii) The process of cellular respiration releases energy because the energy released when the bonds that are formed in CO_2 and water is greater than the energy required to break the bonds of sugar and oxygen.
Item Format	SR	

Scoring Rubric:

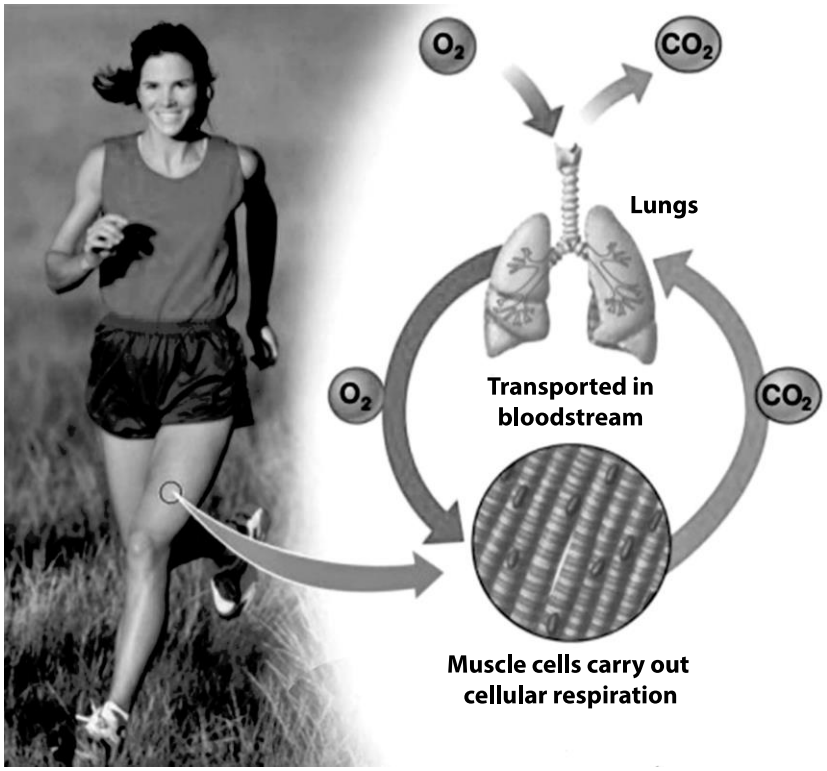
Item	Number of Points	Scoring Criteria
1	0-1	1 Pt: Answer choice B. The chemical reaction of oxygen and food molecules releases energy as the bonds of food molecules and oxygen molecules are broken and new compounds are formed.

Scoring Notes:

Assign one point for correct answer. Tally the points.

Item 1

David and Maria go for a run through Rock Creek Park in Washington, DC.



Maria stops and rests for a moment. She's feeling tired and is worried that she didn't eat enough before her run to maintain the energy levels she needs.

Cellular respiration is a chemical process that occurs in all human cells, including muscle cells.

How does this process produce new compounds that can transport energy for Maria's muscles to use while running?

A. Sugar and oxygen are produced from carbon dioxide and water, resulting in the release of energy that can be used by muscles.
B. The chemical reaction of oxygen and food molecules releases energy as the bonds of food molecules and oxygen molecules are broken and new compounds are formed.
C. The reaction between food molecules and oxygen causes matter to be converted directly to energy, which can be used by muscle cells.
D. Food and oxygen molecules react and combine to form larger, higher-energy molecules, which can be used by muscle cells for energy.

Item 2: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
Science & Engineering Practice(s)	2	Developing and Using Models. Use a model based on evidence to illustrate the relationships between systems or between components of a system.
Disciplinary Core Idea(s)	LS1.C	Organization for Matter and Energy Flow in Organisms. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
Cross cutting Concept(s)	Energy and Matter	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
NGSS Evidence Statement(s)	1a	Components of the model (a) From the given model, students identify and describe the components of the model relevant for illustrating that photosynthesis transforms light energy into stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen, including: (i) Energy in the form of light; (ii) Breaking of chemical bonds to absorb energy; (iii) Formation of chemical bonds to release energy; (iv) Matter in the form of carbon dioxide, water, sugar, and oxygen. Students identify the following relationship between components of the given model: Sugar and oxygen are produced by carbon dioxide and water by the process of photosynthesis.
Item Type	CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
2	0-2	1 Pt: Describe that matter for sugar and oxygen come from matter in carbon dioxide and water. 1 Pt: Stating that energy in the bonds of sugar and oxygen come from light energy from the sun plus the energy from breaking the bonds of carbon dioxide and water.

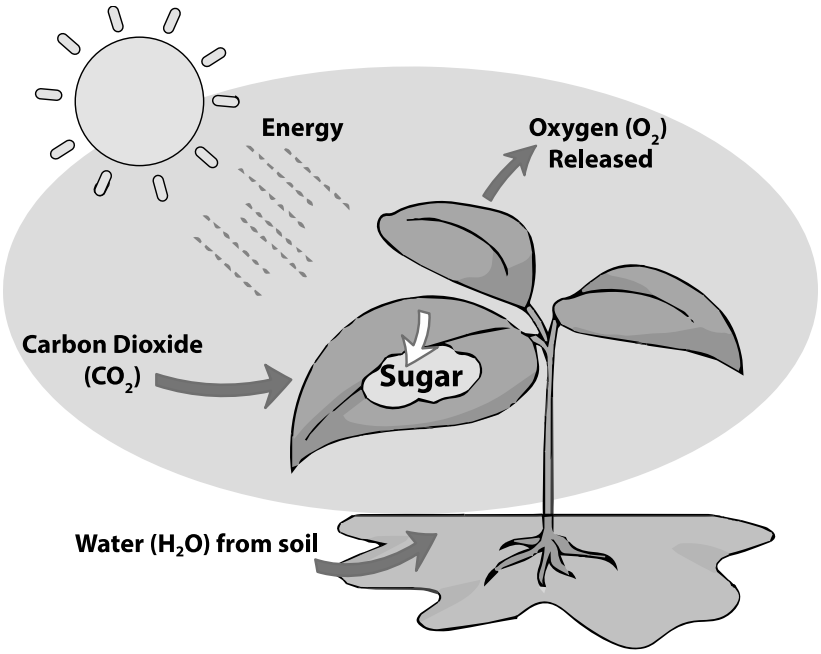
Scoring Notes:

It is not sufficient to say that the energy in the bonds of sugar and oxygen come only from the energy from breaking the bonds of carbon dioxide and water. Light energy from the sun must be included.

Assign one point for correct answer. Tally the points.

Item 2

David and Maria take a break from running. David looks around at all the plant life along the trails in Rock Creek Park and says to Maria, “Isn’t it interesting how the energy and oxygen we need to run come originally from plants? I wonder how plants are able to produce the sugar we use for food and the oxygen we breathe.”



Using the model above, identify the components of photosynthesis and describe how energy and matter are transferred to produce sugar and oxygen.

Item 3: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
Science & Engineering Practice(s)	2	Developing and Using Models. Use a model based on evidence to illustrate the relationships between systems or between components of a system.
Disciplinary Core Idea(s)	LS2.B	Cycles of Matter and Energy Transfer in Ecosystems. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
Cross cutting Concept(s)	Systems and System Models	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows— within and between systems at different scales.
NGSS Evidence Statement(s)	1a	(1) Components of the model (a) Students use evidence to develop a model in which they identify and describe the relevant components, including: (i) The inputs and outputs of photosynthesis; (ii) The inputs and outputs of cellular respiration; (iii) The biosphere, atmosphere, hydrosphere, and geosphere.
Item Type	TEI	

Scoring Rubric:

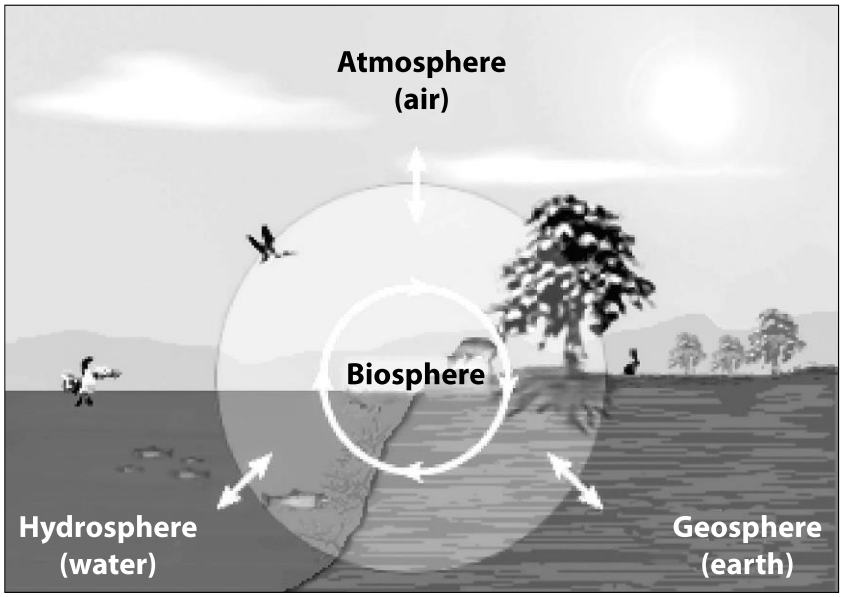
Item	Number of Points	Scoring Criteria
3	0-5	1 Pt: For each correct answer A. Geosphere B. Biosphere C. Hydrosphere D. Biosphere E. Atmosphere

Scoring Notes:

Assign one point for each correct answer. Tally the points.

Item 3

As they begin to run again, Maria explains how animals and plants work together to form a cycle of matter and energy using photosynthesis and cellular respiration.



Select a statement, and drag and drop it to the appropriate box based on which part of the earth is described by each statement.

Biosphere	Atmosphere	Geosphere	Hydrosphere

A. Carbon from dead organisms is stored in sediments and deposits in the earth.
B. Animals eat food and breathe oxygen for energy.
C. Carbon dioxide from the air is dissolved in ocean water.
D. Plants use energy from the sun to produce sugar and oxygen.
E. Carbon dioxide and methane in the air trap heat energy to help warm the earth.

Item 4: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
Science & Engineering Practice(s)	6	Constructing Explanations and Designing Solutions. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
Disciplinary Core Idea(s)	LS2.B	Cycles of Matter and Energy Transfer in Ecosystems. Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
Cross cutting Concept(s)	Energy and Matter	Energy drives the cycling of matter within and between systems.
NGSS Evidence Statement(s)	1a	1 Articulation of phenomena (a) Students construct an explanation that includes that: (i) Energy from photosynthesis and respiration drives the cycling of matter and flow of energy under aerobic or anaerobic conditions within an ecosystem. (ii) Anaerobic respiration occurs primarily in conditions where oxygen is not available.
Item Type	TEI	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
4	0-3	1 Pt: For each correct answer choice--A, D, E.

Scoring Notes:

Assign one point for each correct answer choice. Tally the points.

Item 4

David's muscles start to ache while he's running through the park. He sits down and says to Maria, "My muscles start to ache after I've been exercising and get out of breath, but they continue to work while I run. Is this special to muscle cells, or are there other kinds of cells that are able to continue functioning when they don't get enough oxygen?"

Maria replies, "Oh, do you mean like decomposers in a compost heap when there's no oxygen? I am pretty sure all cells stop functioning and start to die when they lack oxygen. I think that's what's happening when your leg muscles start to ache. "

David responds, "I don't think so. I think there are other types of cells that continue to function, even in anaerobic conditions when oxygen is not present."

Select all the statements that are evidence of cells continuing to function in anaerobic conditions in different environments.

A. Under the anaerobic conditions of landfills, microorganisms are able to digest and convert organic substances into methane gas and other compounds.

B. As a result of being caught in an avalanche, an arctic hare suffocates and dies from lack of oxygen.

C. An algal bloom consumes all the oxygen in an ocean zone, resulting in the death of other animals that need oxygen to survive.

D. Deep ocean vents, which have extremely low oxygen levels, contain microorganisms that are able to survive using chemical processes for cycling matter and energy.

E. Due to high levels of water saturation, as well as warm weather, wetlands are a significant source of atmospheric methane, produced by bacteria in anaerobic conditions.

Item 5: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
Science & Engineering Practice(s)	1	Asking Questions and Defining Problems. Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
Disciplinary Core Idea(s)	ETS1.A	Defining and Delimiting Engineering Problems. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Humanity faces major global challenges today, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
Cross cutting Concept(s)	Influence of Science, Engineering, and Technology on Society and the Natural World	New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
NGSS Evidence Statement(s)	3a	3 Defining the criteria and constraint (a) Students specify qualitative and quantitative criteria and constraints for acceptable solutions to the problem.
Item Type	TEI	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
5	0-12	6 Pts: Design A: 0,0,2,2,1,2 6 Pts: Design B: 2,2,0,0,2,0

Criteria	Design A	Design B
Wheelchair must be portable	*0*	*2*
Wheelchair must be inexpensive to construct.	*0*	*2*
Wheelchair must be lightweight.	*2*	*0*
Wheelchair must allow for greater range of upper body movement.	*2*	*0*
Wheelchair must go fast on pavement.	*1*	*2*
Wheelchair must go fast on dirt trail.	*2*	*0*

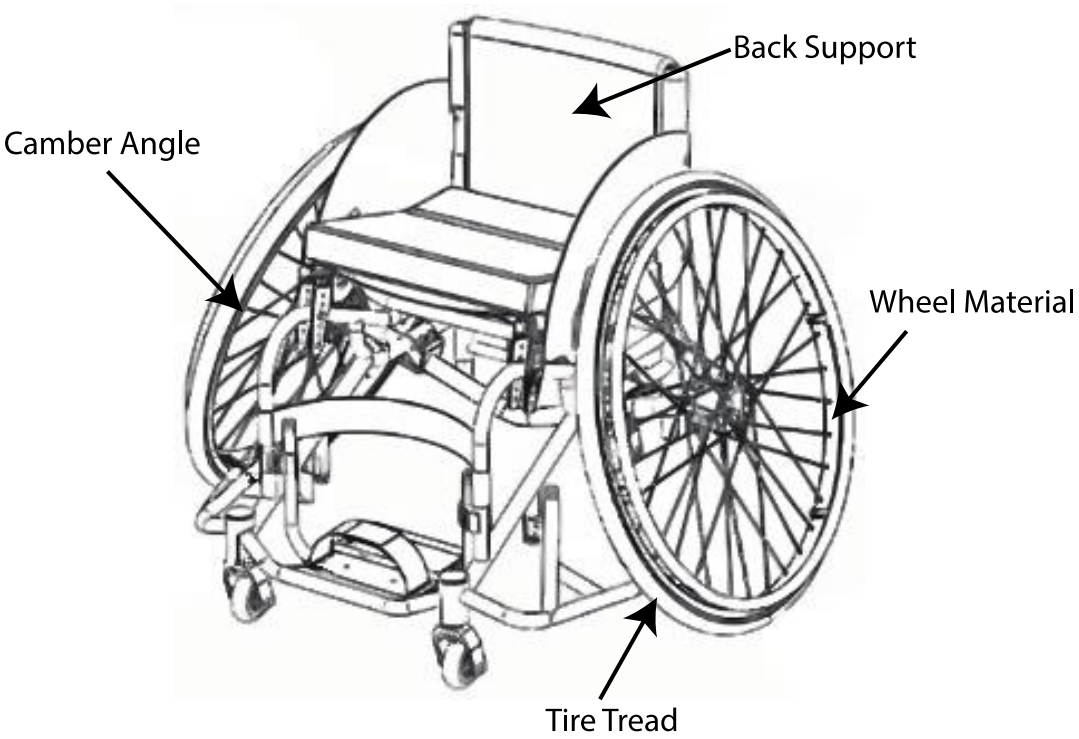
Scoring Notes:

Assign one point for each correct answer. Tally the points.

Item 5

As David and Maria finish their run, they see their friend Joy, who uses a wheelchair, and invite her to join them on a future run. Joy has been interested in getting into road racing, but she knows she would need to get a new wheelchair that is better suited for that sport.

Wheelchairs come in many different shapes and sizes to accommodate people with different needs, as well as to accommodate for different types of activities. David and Maria want to help Joy figure out the best type of wheelchair to buy in order to train in the park with her friends and to participate in road races. The park paths consist of a mix of dirt trails and flat pavement, while the road races are held entirely on flat pavement.



Back supports vary based on how much maneuverability is required of the user. Shorter back supports allow the user a larger range of motion, but require more core strength from the user. Taller back supports are typically more comfortable and provide better back support, but allow for a smaller range of motion.

Wheel camber is the angle of the wheel relative to vertical. A larger wheel camber protects the hands while pushing and puts less strain on shoulders. It makes turning easier and gives more lateral stability while turning. Wheelchairs with an adjustable camber can be more expensive, but can be wider and take up more space.

Tire tread, like the tire tread on a bike, is the material that is in constant contact with the surface on which the user is riding. On paved roads, a smoother tire tread allows for higher speeds. On gravel or dirt trails, however, a thicker tire with a bumpier tread provides better traction on the surface.

Wheel material: Carbon fiber is a lightweight and extremely durable material; however it may be expensive. Steel is heavier than carbon fiber, but it is a much less expensive material to use.

Wheelchair Design A
This more expensive carbon fiber wheelchair has a thick, uneven tire tread. The back support of this wheelchair is low, but the wheelchair as a whole is very large and difficult to transport due to the large camber of the wheel. This wheelchair is faster on pavement than Joy's current wheelchair, but is not as fast as other wheelchairs with a smooth tire tread. It is, however, very fast on dirt trails.

Wheelchair Design B
This less expensive wheelchair is made of sturdy steel, and it has a thin smooth tire tread. The back support of this wheelchair is very comfortable due to its height. The camber angle is close to zero, resulting in a compact and easy-to-transport wheelchair. This wheelchair travels fast on pavement, but it is not recommended for travel on dirt trails.

The matrix below shows criteria that are desired for the selected wheelchair design. Fill in the table by using the drop-down menu in each box to indicate the degree to which the solution satisfies that criteria, based on the information provided about Design A and B.

Use the following criteria values for the drop-down menu values:
Unsatisfied- 0
Partially satisfied- 1
Satisfied-2

Criteria	Design A	Design B
Wheelchair must be portable	*0*	*2*
Wheelchair must be inexpensive to construct.	*0*	*2*
Wheelchair must be lightweight.	*2*	*0*
Wheelchair must allow for greater range of upper body movement.	*2*	*0*
Wheelchair must go fast on pavement.	*1*	*2*
Wheelchair must go fast on dirt trail.	*2*	*0*

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Item 6: Metadata, Scoring Rubric, & Scoring Notes

Metadata:

Performance Expectation	HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
Science & Engineering Practice(s)	1	Asking Questions and Defining Problems. Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
Disciplinary Core Idea(s)	ETS1.A	Defining and Delimiting Engineering Problems. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Humanity faces major global challenges today, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
Cross cutting Concept(s)	Influence of Science, Engineering, and Technology on Society and the Natural World	New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
NGSS Evidence Statement(s)	2a-b	2 Defining the process or system boundaries, and the components of the process or system (a) In their analysis, students identify the physical system in which the problem is embedded, including the major elements and relationships in the system and boundaries so as to clarify what is and is not part of the problem. (b) In their analysis, students describe societal needs and wants that are relative to the problem.
Item Type	CR	

Scoring Rubric:

Item	Number of Points	Scoring Criteria
6	0-2	1 Pt: Identifying that Design A is the better design. 1 Pt: Using evidence to describe that while Design A is more expensive and more difficult to transport than Design B, the shorter back support allows for more range of motion, which is better for racing, and it is lightweight and fast on both pavement and dirt trails. Design B is not suitable for use on dirt trails.

Scoring Notes:

- For full credit, the response should address why Design A is better AND why Design B is not a good choice, since it is not suitable for use on dirt trails.

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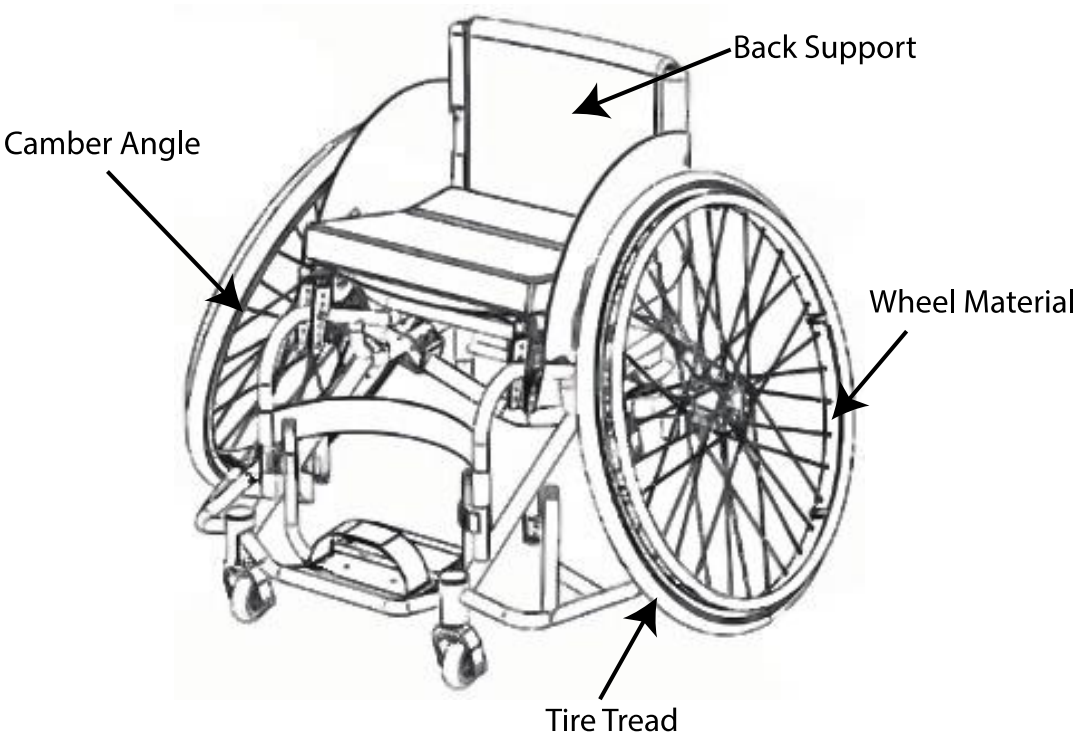

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Based on the wheelchair design descriptions and Joy's design constraints, identify which wheelchair design better supports her needs. Explain the ratings of the constraints for each solution, and use evidence to justify your answer.